within the body of a single polyp, whereas the so similar-looking radiating plates in the case of the cyclosystem are skeletal plates developed outside the bodies of the numerous component polyps altogether, and separating a number of adjacent polyps from one another. The peculiar radiate form of the cyclosystems of the Stylasterids has no doubt been gradually developed as the result of the constant bending inwards of the dactylozooids in each system to reach their gastrozooid when further and further retracted within its pore. The dactylozooids have thus in course of generations pulled the mouths of their pores out into the form of slits all directed inwards towards the gastropore in each system. In the case of some genera the gastrozooids have carried matters so far that they have ceased to be retracted within their own pores when at rest, but double themselves inwards for safety within the wide mouths of their gastropores. In one genus (Cryptohelia) a further protection is afforded to the zooids by the growth in front of each system of a delicate lid-like lamina of hard coral skeleton, which projects in front, and shields all the zooids when retracted.

In some genera of Stylasteridæ the zooids are not gathered into cyclosystems at all, but various other complications occur. Thus, in some genera there are two kinds of dactylozooids, larger and smaller. The larger and longer, in order to gain more reach in procuring food, are borne at the tips of long spine-like projections of the hard skeletons of the corals, whilst the smaller dactylozooids are lodged in small pores at the bases of these spines where they are in close proximity to the gastrozooids. The larger dactylozooids presumably catch the food, and are helped in delivering it to the gastrozooids by their shorter companions.

As before stated, the mode of generation of the Milleporidæ is as yet unknown, but it is certain that it differs in one important particular from that of the Stylasteridæ. In these latter small cavities, or brood pouches, termed ampullæ, are formed in the hard skeleton of the coral, and in these the generative elements are developed. Each coral stock is of separate sex, all its components being either male or female. The walls of the ampullæ in many cases project above the surfaces of the corals, and are especially prominent in female stocks, since they have in these cases to contain large embryos. In some specimens of Stylasteridæ the ampullæ are very conspicuous to the naked eye, looking like small convex blisters closely packed on the surfaces of the coral branches. They are particularly well marked in the case of female stocks of species of Distichopora, which are thus especially serviceable for class demonstration, and when the generative function of the ampullæ is premised, afford evidence at a glance of the hydroid nature of the Stylasteridæ. The ova are developed within the ampullæ to the condition of mature planulæ, when they are set free by the gradual thinning and final rupture of the ampullar walls and swim off to start fresh colonies. It is highly probable that the masses of tissue from which the ova are developed, and which protect them during growth, are representatives of polyps, which have, like the dactylozooids, lost their mouths, and have come by restriction of function to be mere egg-bags as it were.

In all the Stylasteridæ, even those with very complex cyclosystems, there is a complete circulatory connection between the different systems and all parts of the colony, as well as amongst the components of each system. Thus in these complex mutual benefit associations, certain members of the colonies catch the food, but do not eat it, others receive it from them and nourish the whole colony thereby, whilst others again neither catch food nor eat it, but devote themselves entirely to the production and rearing of the young.

The ancestral forms from which the Hydrocorallinæ have been developed must have been colonies closely similar in essential structure to their present descendants, but with all their component zooids provided with mouths and generative organs, all alike catching food and digesting it, and possibly all taking their share in the production of young. In such colonies further development may be conceived of as having arisen by either of two processes. All the zooids may have become gradually modified, so that each performed only one function and thus had certain of its structures aborted to fit it for this special end. If such be the history of the development of the Hydrocorallinæ then the dactylozooids are to be looked on as they have been regarded throughout this paper as representatives of zooids which in the ancestral condition were provided with a mouth and stomach, but in which these structures as well as the generative structures have become rudimentary by disuse. Similarly in the case of the gasterozooids the functions of prehension have to a large extent been lost, and the zooids have become, in some cases, mere stomachs.

On the other hand the view may be taken that the gastrozooids alone represent the original zooids of the ancestral colony. They remain, having lost their generative organs and to a greater or less extent their prehensile ones because additional zooids have been formed by budding in order to provide for the wants of the colony in these particulars. On this view the generative zooids and dactylozooids were originally budded out in the condition in which they now exist or in one not so complete as it is at present, nor so perfectly adapted to their present function. On this view they have lost no structure by disuse, but have rather advanced in complexity with development but only in their own specialised direction.

The former view of the antecedent history of the suborder Hydrocorallinæ has been here adopted, because the presence of several structures which occur as rudiments in connection with the dactylozooids and generative zooids, but which are fully developed in connection with the gastrozooids, seem to bear out this conclusion. As examples may be cited the calcareous styles which gave the name to the family Stylasteridæ. These styles are small projections of the hard skeletons of the corals which support the gastrozooids within their pores. In several genera rudimentary styles are found to occur in connection with the dactylozooids.

The Stylasteridæ, in the complexity of their compound stocks, form an interesting parallel to the Siphonophora. In the Siphonophora the several components of the compound organisms are by the best authorities regarded not as individual zooids, but as portions of the organisms which, being budded out, tend in their growth to assume more and more the form of individuals. The question is to some extent one of nomenclature, but it must not be forgotten that though the diverse elements composing the organism in the case of the Siphonophora may seem closely paralleled by those of which that of a Stylasterid is made up, the past history of the two organisms may be very different. In the one case an ancestral already compound organism may have gradually modified its similar zooids to subserve division of labour, whilst in the other a simple ancestor may have gradually developed a similar compound organism by throwing out buds of various forms, which have come more or less to approach itself in complexity.

H. N. MOSELEY

IRIDO-PLATINUM

THE volume of the *procès-verbaux* of the International Commission of Weights and Measures published in Paris last year,[1] contains, among other matter of much value, an interesting appendix by MM. Sainte-Claire Deville and Stas, who were requested by the Commission to ascertain the composition of the platinum-iridium alloy employed in the preparation of the rules and cylinders destined to serve as the International Prototype Standards. Their investigations are set forth at great length, and analytical chemistry is thus enriched by an elaborate memoir, in every way worthy of its distinguished authors. The alloys of platinum iridium, of which these standards are made, was furnished by Mr. George Matthey, of the well-known firm of Johnson, Matthey, and Co., and, in the April number of the *Annales de Chimie*, there is a paper by MM. Deville and Mascart, describing the experimental determinations of the various physical constants of the metal of which the Règle Géodésique is made. We cannot do better than quote their words as indicating the care and skill bestowed by Mr. Matthey in the preparation of this standard: "En fabriquant un pareil alliage avec une telle pureté, M. Matthey a résolu un problème de métallurgie des plus difficiles et des plus compliqués. On ne peut s'imaginer, à moins qu'on ne connaisse dans tous leurs détails les procédés si pénibles employés à la purification de l'iridium et même du platine, combien il a fallu d'intelligence, de patience et de dévouement à la Science pour réussir dans une pareille œuvre." [1]

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[1] Gauthier-Villars. Paris, 1878.

As the matter is of much importance, a paper recently communicated to the Royal Society by Mr. G. Matthey possesses special interest, as in it he describes the methods employed for preparing the metals in a state of purity. The following is an abstract:—

"The six metals (of which platinum is the chief) usually found more or less in association, present characteristics of interest beyond their metallurgical utility, which are, perhaps, worth alluding to. It is, for instance, a curious fact that the group should consist of three light and three heavy metals, each division being of approximately the same specific gravity—the heavier having (in round figures) just double the density of the lighter series.

Thus we find osmium, iridium, platinum forming the first division, of the respective specific gravities of 22·43, 22·39, 21·46; whilst ruthenium, rhodium, and palladium are represented by the figures 11·40, 11·36, 11, the average densities of the heavy and light divisions thus being respectively 22·43 and 11·25.

But a more interesting and important classification is what I may designate as a first and second class series, from the more important view of their relative properties of stability. Thus platinum, palladium, and rhodium form the first or higher class, not being volatilisable in a state of oxide; iridium, osmium, and ruthenium forming the second or lower class, their oxides being more or less readily volatilised.

The oxide of iridium is affected at 700° to 800° C., and entirely decomposed at 1,000°, whilst osmic and hypo-ruthenic acids are volatilised at the low degree of 100°, the latter exploding at 108°. The chlorides of these metals can be sublimed at different temperatures (as also the protochloride of platinum).

Platinum

The preparation of this metal in a state of purity is an operation of extreme delicacy. I commence by taking ordinary commercial platinum; I melt this with six times its weight of lead of ascertained purity, and, after granulation, dissolve slowly in nitric acid diluted in the proportion of 1 volume to 8 of distilled water. The more readily to insure dissolution, it is well to place the granulated alloy in porcelain baskets such as are used in the manufacture of chlorine gas for holding the oxide of manganese. When the first charge of acid is sufficiently saturated, a fresh quantity should be added until no more action is apparent; at this stage the greater part of the lead will have been dissolved out, together with a portion of any copper, iron, palladium, or rhodium that may have been present. These metals are subsequently extracted from the mother-liquors, the nitrate of lead by crystallisation, and the remaining metals by well-known methods.

The metallic residue now obtained will be found in the state of an amorphous black powder (a form most suitable for further treatment), consisting of platinum, lead, and small proportions of the other metals originally present—the iridium existing as a brilliant crystalline substance insoluble in nitric acid. After digesting this compound in weak aqua regia, an immediate dissolution takes place of the platinum and lead, leaving the iridium still impure, but effecting a complete separation of the platinum.

To the chloride of platinum and lead after evaporation is added sufficient sulphuric acid to effect the precipitation of the whole of the lead as a sulphate, and the chloride of platinum, after dissolution in distilled water, is treated with an excess of chloride of ammonium and sodium, the excess being necessary in order that the precipitated yellow double salt may remain in a saturated solution of the precipitant. The whole is then heated to about 80°, and allowed to stand for some days; the ammonio-chloride of platinum will settle down as a firm deposit at the bottom of the vessel, whilst if any rhodium, as is generally the case, is present, the surface liquor will be coloured a rose tint, occasioned by a combination of the salts of the two metals.

The precipitate must be repeatedly washed with a saturated solution of chloride of ammonium and subsequently with distilled water charged with pure hydrochloric acid. This is necessary for its purification. The small quantity of the double salt which will be taken up and held in solution is of course recovered afterwards. Rhodium may still exist in the washed precipitate, which must therefore not be reduced to the metallic state until its separation is completed, and this is best effected by mixing with the dried compound salts of chloro-platinate and chloro-rhodiate of ammonia, bi-sulphate of potash with a small proportion of bi-sulphate of ammonia, and subjecting to a gradual heat brought by degrees up to a dull red in a platinum capsule, over which is placed an inverted glass funnel. The platinum is thus slowly reduced to a black spongy porous condition freed from water, nitrogen, sulphate of ammonia, and hydrocloric acid, the rhodium remaining in a soluble state as bi-sulphate of rhodium and potash, which can be dissolved out completely by digesting in boiling distilled water; a small quantity of platinum will have been taken up in the state of sulphate, but is regained by heating the residue (obtained on evaporation) to redness, which reduces it to the metallic condition, the rhodium salt remaining undecomposed.

By the method above described the platinum is freed not only from rhodium, but from all other metals with which it may have been contaminated, and is brought to a state of absolute purity, of the density 21·46, the highest degree obtainable.

Iridium

In practice, the purest iridium which can be obtained from its ordinary solution (deprived of osmium by long boiling in aqua regia and precipitated by chloride of ammonium) will almost invariably contain traces of platinum, rhodium, ruthenium, and iron.

I fuse such iridium in a fine state of division with ten times its weight of lead, keeping it in a molten state for some hours, dissolve out the lead with nitric acid, subject the residue to a prolonged digestion in aqua regia, and obtain a crystalline mass composed of iridium, rhodium, ruthenium, and iron, in a condition suitable for my further treatment. By fusion at a high temperature with an admixture of bi-sulphate of potash, the rhodium is almost entirely removed, any remaining trace being taken up together with the iron in a later operation. The iridium so far prepared is melted with ten times its weight of dry caustic potash, and three times its weight of nitre, in a gold pan or crucible; the process being prolonged for a considerable time to effect the complete transformation of the material into iridiate and rhuthenate of potash, and the oxidation of the iron; when cold, the mixture is treated with cold distilled water. The iridiate of potash of a blue tinge will remain as a deposit almost insoluble in water, more especially if slightly alkaline, and also the oxide of iron.

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[1] *Ann. de Chim. et de Phys.*, 5me Série, t. xvi., April, 1879.

This precipitate must be well washed with water charged with a little potash and hypochlorite of soda until the washings are no longer coloured, and then several times with distilled water.

The blue powder is then mixed with water strongly charged with hypochlorite of soda, and allowed to remain for a time cold, then warmed in a distilling vessel, and finally brought up to boiling point until the distillate no longer colours red, weak alcohol acidulated with hydrochloric acid.

The residue is again heated with nitre and potash water charged with hypochlorite of soda and chlorine, until the last trace of ruthenium has disappeared.

Further, to carry out the purification, the blue powder (oxide of iridium) is re-dissolved in aqua regia, evaporated to dryness, re-dissolved in water, and filtered.

The dark-coloured solution thus obtained is slowly poured into a concentrated solution of soda and mixed with hypochlorite of soda, and should remain as a clear solution without any perceptible precipitate, and subjected in a distilling apparatus to a stream of chlorine gas, should not show a trace of ruthenium when hydrochloric acid and alcohol are introduced into the receiver. In this operation the chlorine precipitates the greater part of the iridium in a state of blue oxide, which, after being collected, washed, and dried, is placed in a porcelain or glass tube, and subjected to the combined action of oxide of carbon and carbonic acid obtained by means of a mixture of oxalic with sulphuric acid gently heated.

The oxide of iridium is reduced by the action of the gas leaving the oxide of iron intact, the mass is then heated to redness with bi-sulphate of potash (which will take up the iron and any remaining trace of rhodium), and after subjecting it to many washings with distilled water, the residue is washed with chlorine water to remove any trace of gold, and finally with hydrofluoric acid, in order to take out any silica which might have been accidentally introduced with the alkalies employed or have come off the vessels used.

The iridium after calcination at a strong heat in a charcoal crucible, is melted into an ingot.

Alloy of Iridio-Platinum

Operating upon a charge of 450 ounces of platinum and 55 ounces of iridium, I commenced by melting these metals together and casting into an ingot of suitable shape, which I then cut into small pieces with hydraulic machinery. After re-melting and retaining in a molten condition under a powerful flame of oxygen and common gas for a considerable time, I re-cast and forged the mass at an intense white heat under a steam hammer, the highly-polished surfaces of which were cleaned and polished after each series of blows—when sufficiently reduced the alloy was passed through bright polished steel rollers, cut into narrow strips, and again slowly melted in a properly-shaped mould, in which it was allowed to cool. I thus obtained a mass of suitable shape for forging, perfectly solid, homogeneous, free from fissures or air-holes, and with a bright and clean surface.

A piece cut from the end of a mass so prepared, was presented to the French Academy of Science, and gave the following results :—

Weight in air	116·898 grms.
,, water	111·469 ,,
Showing a density of	21·516 ,,

thus proving that the necessary processes of annealing at a high temperature had caused it to resume its original density.

The analysis gave—

	1	2
Platinum	89·40	89·42
Iridium	10·16	10·22
Rhodium	0·18	0·16
Ruthenium	0·10	0·10
Iron	0·06	0·06
	99·90	99·96

From which is deduced :—

	Proportion.	Density at zero.	Volume.
Iridio-platinum at 10 per cent.	99·33	21·575	4·603
Iridium, in excess	0·23	22·380	0·010
Rhodium	0·18	12·000	0·015
Ruthenium	0·10	12·261	0·008
Iron	0·06	7·700	0·008
	99·90		4·644

Density at zero, calculated after No. 1 analysis 21·510
Density at zero, calculated after No. 2 ,, 21·515

which coincide perfectly with the practical results obtained."

MM. Deville and Mascart find the coefficient of dilatation to be from 0° to 16° C. 0·00002541.

As we have already pointed out, work on which the accuracy of standards depends is of the highest importance, and Mr. Matthey is therefore to be congratulated on the success of his labours.

THE INFLUENCE OF THE TRANSVERSE DIMENSIONS OF ORGAN PIPES ON THE PITCH

IN NATURE, vol. xix. p. 172, Mr. Ellis gives, on the authority of M. Cavaillé-Coll, a rule determining a point of some interest in regard to organ-pipes. All those who are accustomed to organs know that the theoretical rule which makes the vibration-number of the note sounded vary inversely as the length of the pipe, does not hold correctly in practice, as the pitch is influenced by the *transverse dimensions*. A pipe of "large scale," *i.e.*, of large diameter, will speak a lower note than one of "small scale," the length of the tube being in both cases the same. I am not aware that this fact has been explained in acoustical works, or any rule given for the variation.

Mr. Ellis's formula provides for this, so far as cylindrical pipes are concerned, and he has found it to agree well with experiment. There is a misprint in his equation, which at first sight renders it somewhat obscure, and in correcting this I will venture to present M. Cavaillé-Coll's investigation more completely, as it was expressed by him in a paper presented to the Academy of Sciences many years ago, and a copy of which he was good enough to give me.

After calling attention to the theoretical rule, he remarks that the departure from it is due to the influence of the *mouth* of the pipe, *i.e.*, the rectangular opening at the lower end of the tube. He made many experiments to determine the effect of this, and came at length to the result that in open pipes of rectangular section the *effective length of the pipe* was equal to the *length of the sound-wave* due to its note [or the half wave-length according to our mode of calculation] *diminished by twice the internal depth* of the tube. By the "depth" is meant the transverse dimension from front to back; the other transverse dimension, the *width*, appearing to be of no consequence.

Thus, if S represent the velocity of sound, V the number of vibrations per second (*single* ones, according to the French mode of calculation), L the length of the pipe, taken from the lower edge of the mouth to the end of the tube; and P the internal transverse depth, then—

$$L = \frac{S}{V} - 2P.$$